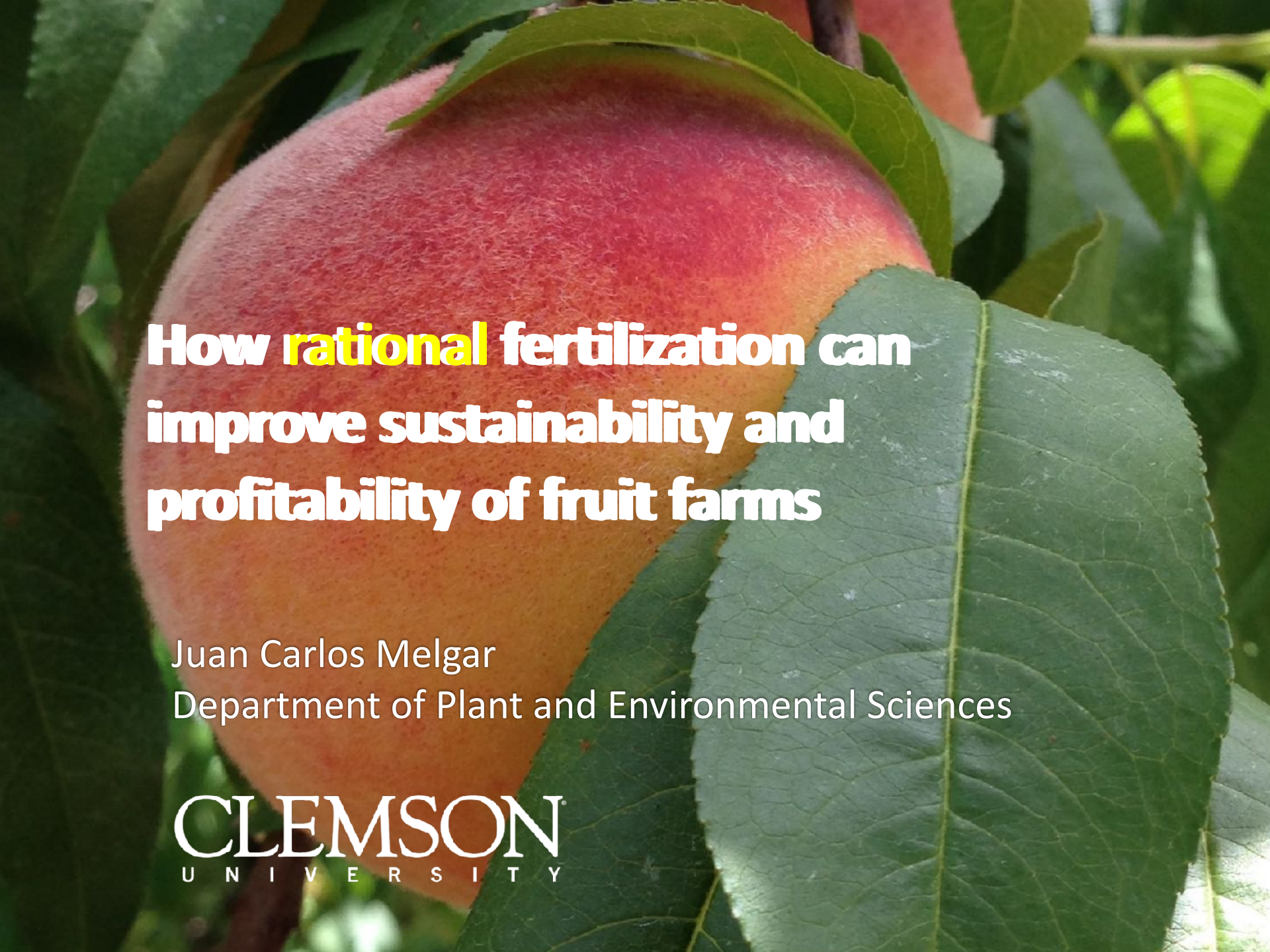

How rational fertilization can improve sustainability and profitability of fruit farms

Juan Carlos Melgar
Department of Plant and Environmental Sciences

CLEMSON
UNIVERSITY

- Consumers demand for high fruit quality standards
- Yield is a great concern for growers
- Societal concerns about over-use of inputs

Reconcile high yield goals with minimal negative impacts on the environment

Published: January 1995

Nitrogen fertilization management in orchards to reconcile productivity and environmental aspects

M. Tagliavini, D. Scudellazi, B. Marangoni & M. Toselli

Fertilizer research **43**, 93–102 (1995) | Cite this article

Causes and Consequences of Overfertilization in Orchards

in HortTechnology

Authors: Steven A. Weinbaum [1], R. Scott Johnson [1], and Theodore M. DeJong [1]

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Online Publication Date: Jan 1992

In years with high occurrence, losses exceed 60% of the fruit of mid-season cultivars

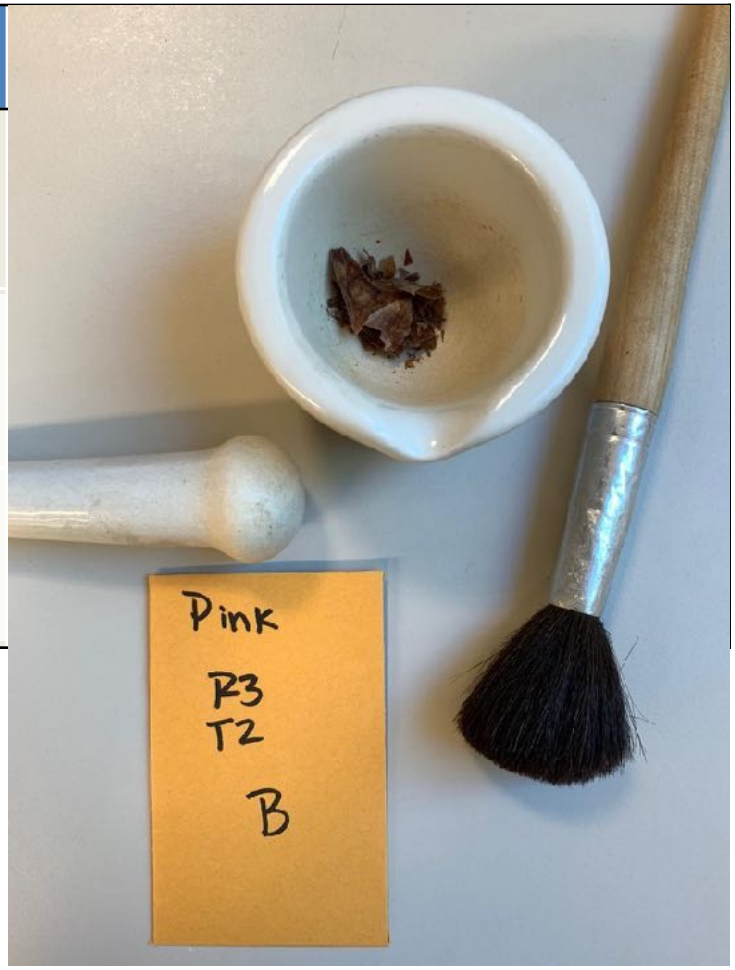

FRAGILE
92-3051

Photo: V. Fernandez, 2011

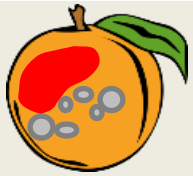
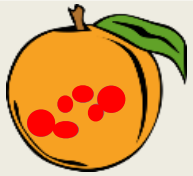
K
Mg
Ca
Mg/K
Ca/K
Ca/Mg
K/(Ca+Mg)
(K+Mg)/Ca

Scarletprince trial

2020	Control (peach w/o bronzing) 
	Areas with no bronzing (peach with bronzing) 
	Areas with bronzing (peach with bronzing) 



Scarletprince trial

		Mg (%)	Mg/K
2020	Control (peach w/o bronzing) 	0.067 b	0.035 b
	Areas with no bronzing (peach with bronzing) 	0.068 b	0.036 b
	Areas with bronzing (peach with bronzing) 	0.076 a	0.041 a

Scarletprince trial

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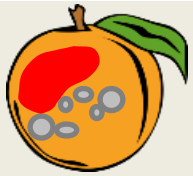
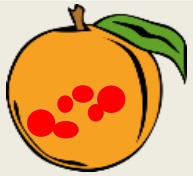
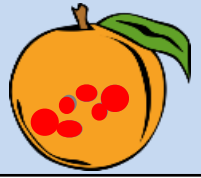
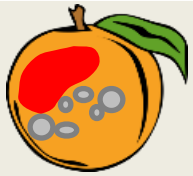
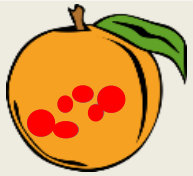
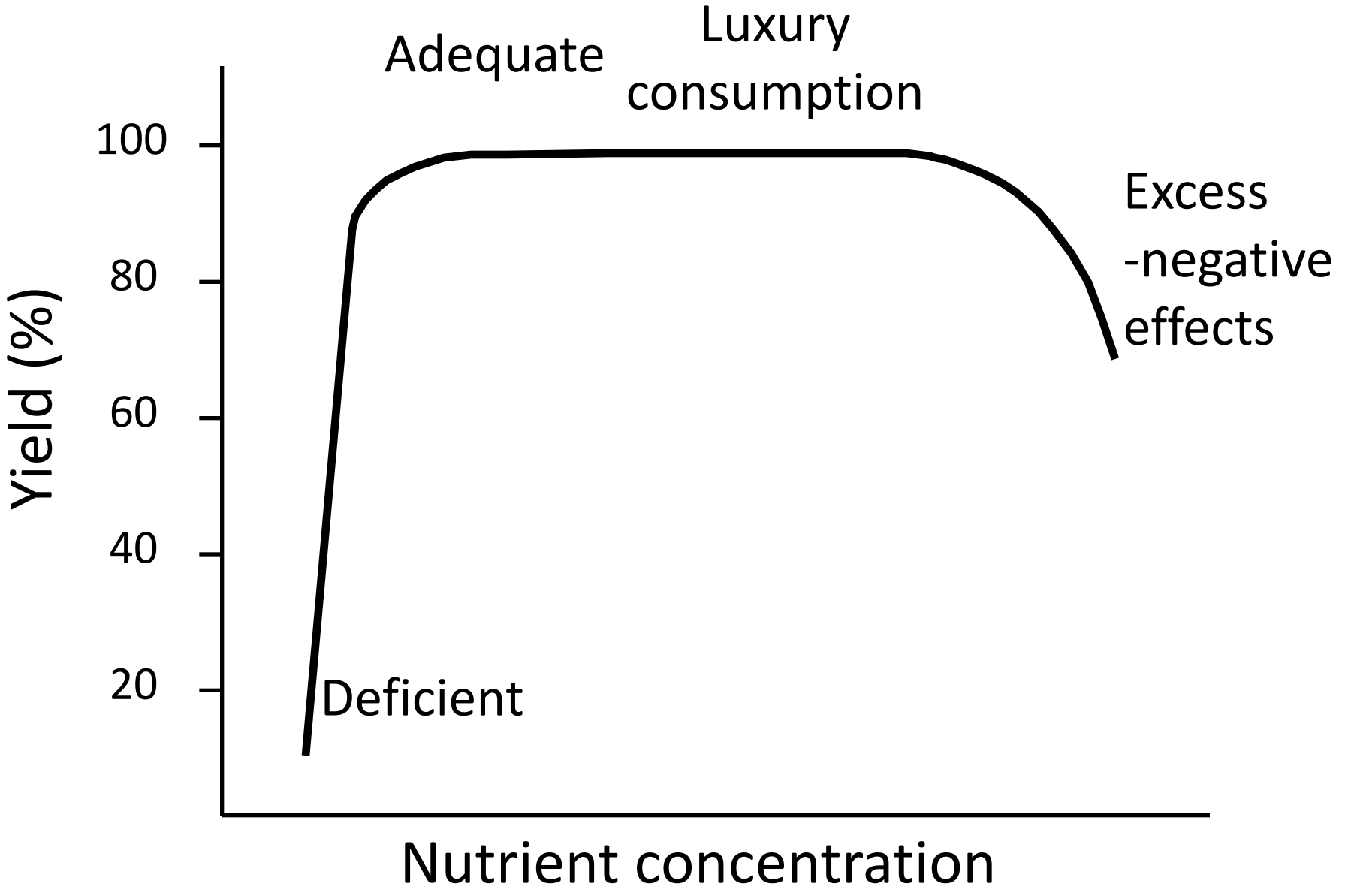
	Areas with no bronzing (peach with bronzing) 	0.068 b	0.036 b
	Areas with bronzing (peach with bronzing) 	0.076 a	0.041 a
2021	Control (peach w/o bronzing) 	0.159 c	0.095 b
	Areas with no bronzing (peach with bronzing) 	0.168 b	0.097 b
	Areas with bronzing (peach with bronzing) 	0.188 a	0.111 a

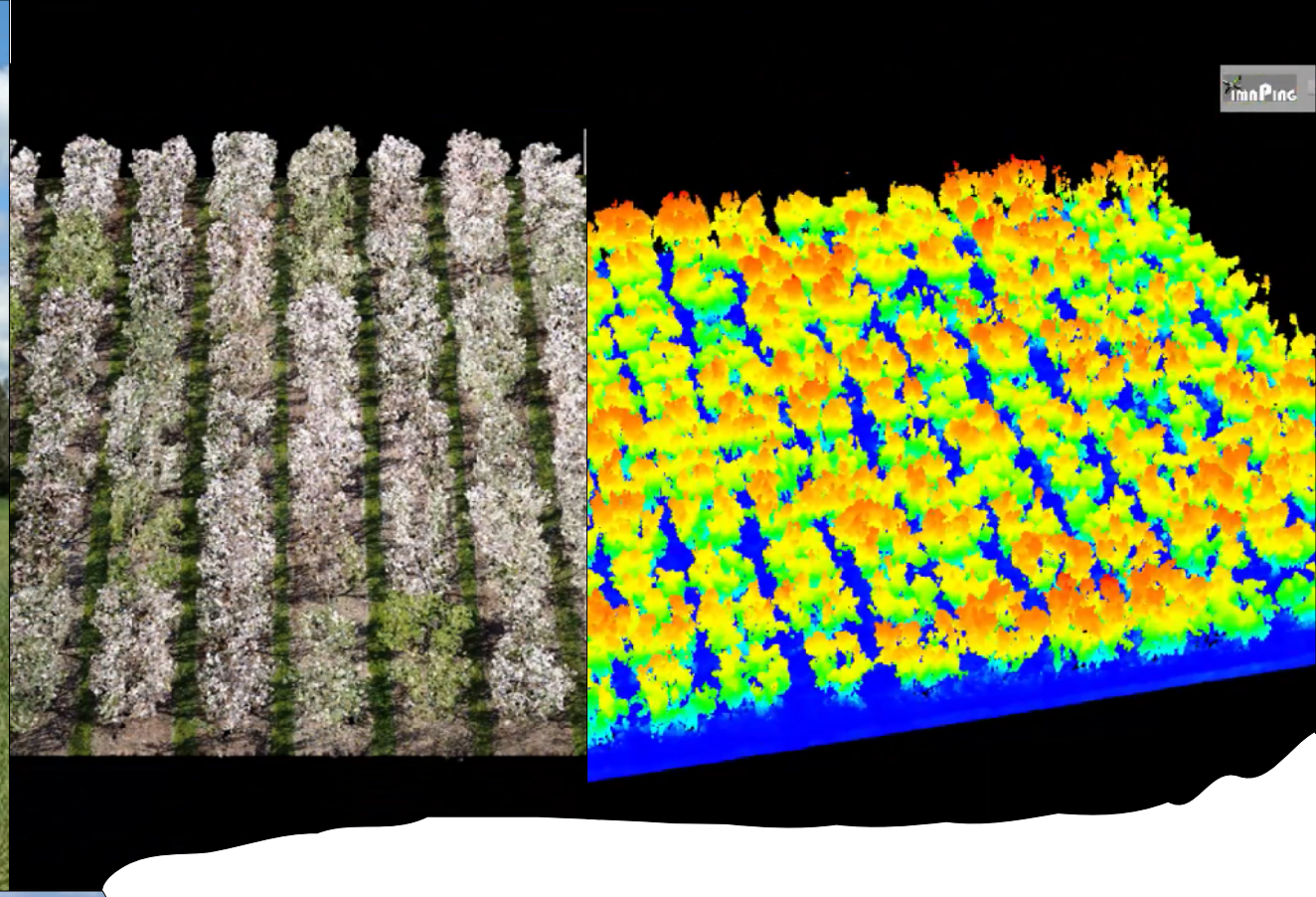
PF-23 trial

		Mg (%)	Mg/K
2021	Control (peach w/o bronzing) 	0.238 b	0.367 b
	Areas with no bronzing (peach with bronzing) 	0.241 b	0.379 b
	Areas with bronzing (peach with bronzing) 	0.271 a	0.395 a


Adequate
Luxury consumption
Excess -negative effects
100
80
60
40
20
Yield (%)
Deficient
Nutrient concentration

Fertilizer (N) = f_x (… … … … … … … …)

- fertilization management (timing, number of applications)
- crop load/yield
- ripening season
- pruning
- tree age and health
- environmental conditions
- soil health/management

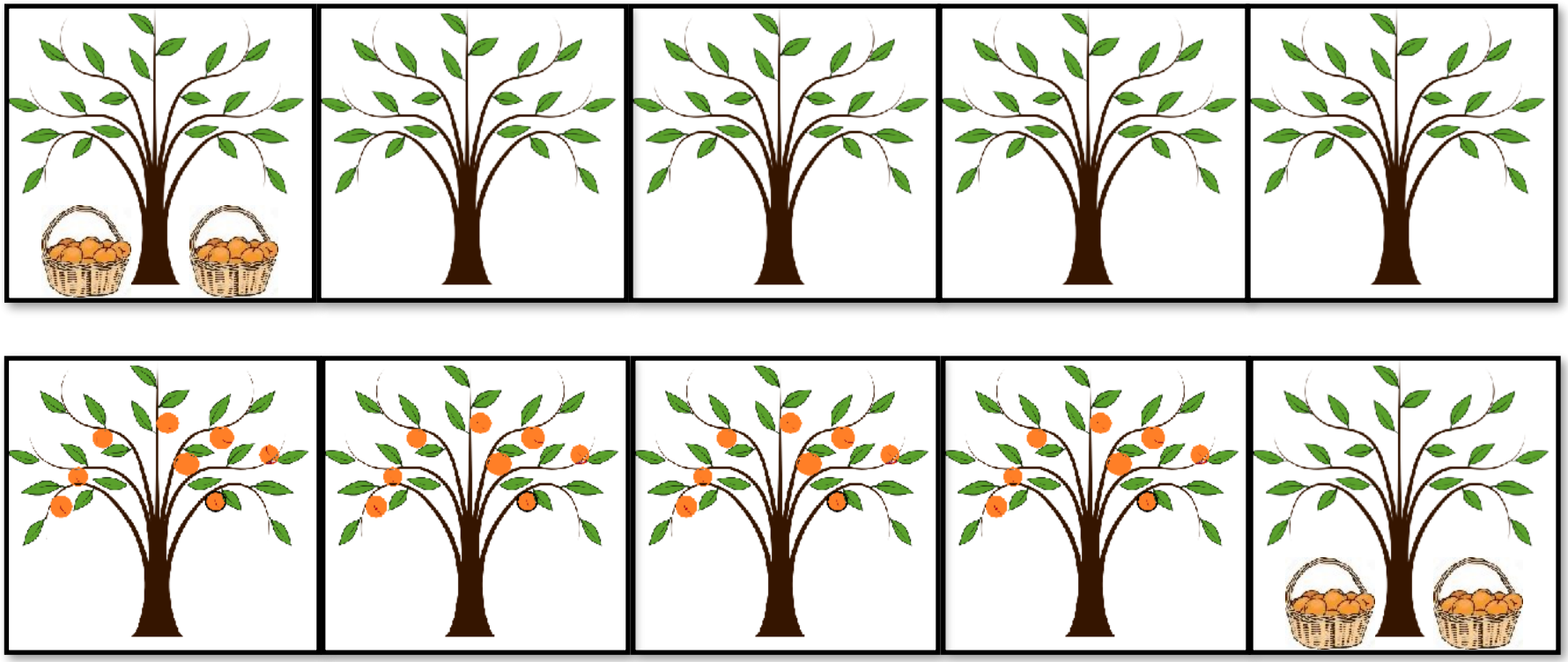


Artificial intelligence and precision agriculture technology

Fertilizer (N) = f_x (… … … … … … … …)

- fertilization management (timing, number of applications)
- crop load/yield
- ripening season
- pruning
- tree age and health
- environmental conditions
- soil health/management

May	June	July	August	September



Nutrient concentration (% D.W.) in fruit

	N	P	K	Ca	Mg
Early	**0.9 a**	**0.2 a**	**2.0 a**	0.03	**0.3 a**
Mid	0.6 b	0.2 b	1.4 b	0.03	0.2 a
Late	0.6 b	0.1 b	1.4 b	0.03	0.2 a

Zhou Q and Melgar JC. 2019. J. Plant Nutr. Soi Sci. 182:20

Nutrient allocation (%)

		N	P	K	Ca	Mg
Pruning wood	Early	55.7	50.3	43.0	53.9	41.6
	Mid	50.0	45.9	32.4	58.6	36.6
	Late	49.6	44.9	27.4	53.3	32.5
Fruit	Early	-	-	-	-	-
	Mid	27.1	29.3	42.2	1.0	23.4
	Late	27.3	32.5	45.0	1.1	23.7
Fallen leaves	Early	23.2	24.3	29.6	45.5	44.0
	Mid	20.0	22.2	23.3	40.4	38.9
	Late	19.9	18.1	25.5	45.6	42.6

Nutrient allocation (%)

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	Late	49.6	44.9	27.4	53.3	32.5
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	Mid	20.0	22.2	23.3	40.4	38.9
	Late	19.9	18.1	25.5	45.6	42.6

Resorbed N provide up to 70% of the N requirement of forming fruits and shoots


Trees pruned early in Fall


Trees defoliated due to leaf rust in October

Potassium concentration in mature and old trees

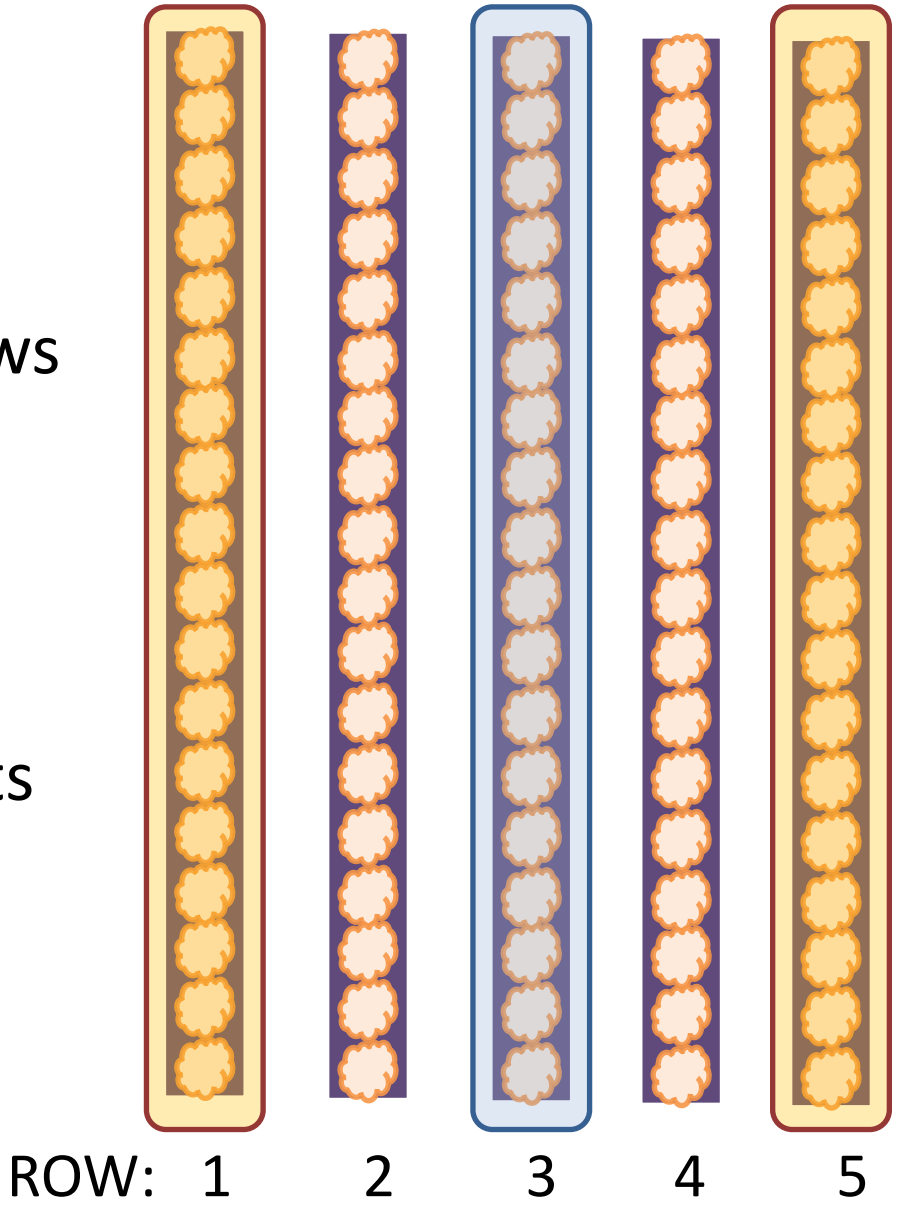
		2015	2016	2017
Pruning wood	Mature	0.9 a	**0.4 b**	0.7 a
	Old	0.8 a	**0.6 a**	0.8 a
Fallen leaves	Mature	**1.9 a**	**2.6 a**	**2.9 a**
	Old	**1.6 b**	**1.6 b**	**1.7 b**

Older trees have an increased potential storage and seem to be more efficient at resorbing nutrients

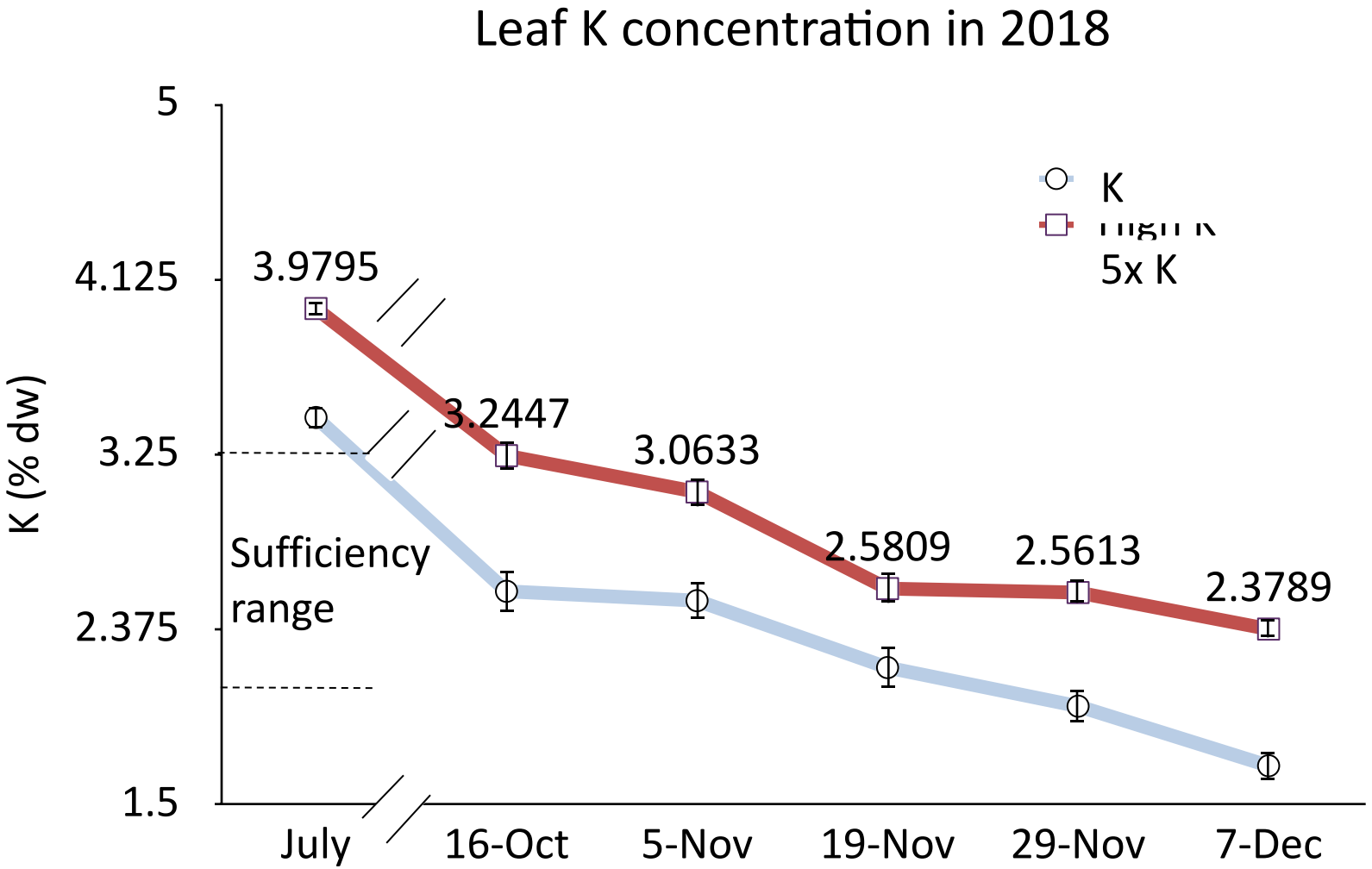
Zhou Q and Melgar JC. 2020. HortScience 55:560-564

Overfertilization with K

- Two high potassium rows (1 and 5)
- On standard K row (3)
- Buffer rows (2 and 4) between the treatments



Leaf Potassium



Leaf nutrient concentration (%) - 2018

	K	Ca	Mg
Standard K	3.4 b	1.7	0.2
5x K	4.0 a	1.5	0.2

	K	Ca	Mg
Deficiency range	0.75-1.0	<1.0	0.10-0.30
Sufficiency range	2.0-3.0	1.5-3.0	0.30-0.80

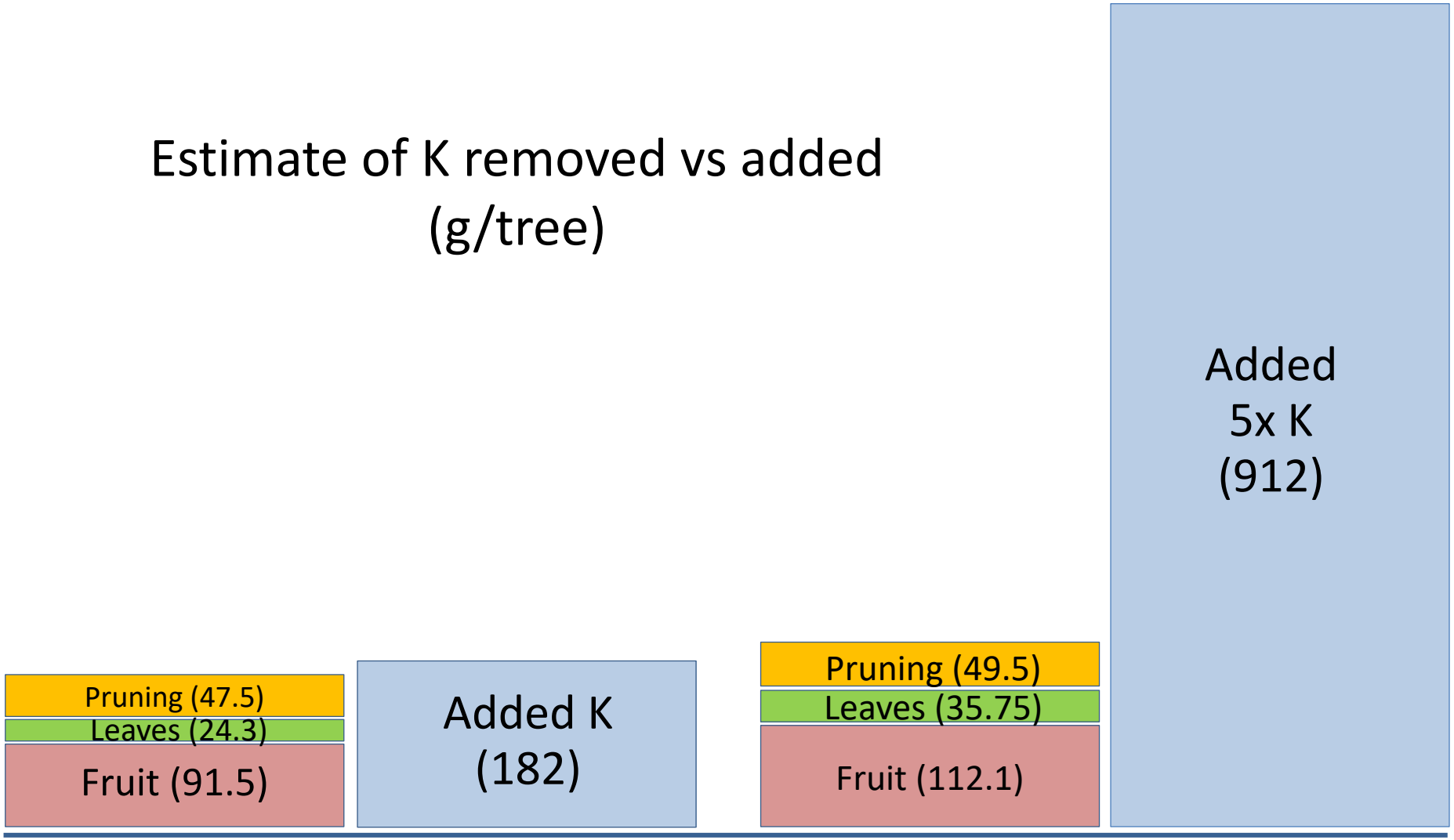
We then decided to cut the standard K rate and do not fertilize with K until K concentrations go to values within the sufficiency ranges

Leaf nutrient concentration (%) - 2020

	K	Ca	Mg
Standard K	3.1	2.2	0.3 a
5x K	3.4	1.9	0.2 b

	K	Ca	Mg
Deficiency range	0.75-1.0	<1.0	0.10-0.30
Sufficiency range	2.0-3.0	1.5-3.0	0.30-0.80

Estimate of K removed vs added (g/tree)



CROPS > ORCHARD CROPS

Lack of winter chill temps a concern for fruit growers

Apple growers in Texas, New Mexico and Arizona s
winter chill hours, loosely defined as the number o
hours the temperature lingers between 32 and 45
degrees, are critical in order for trees to bud. Peac
also at risk.

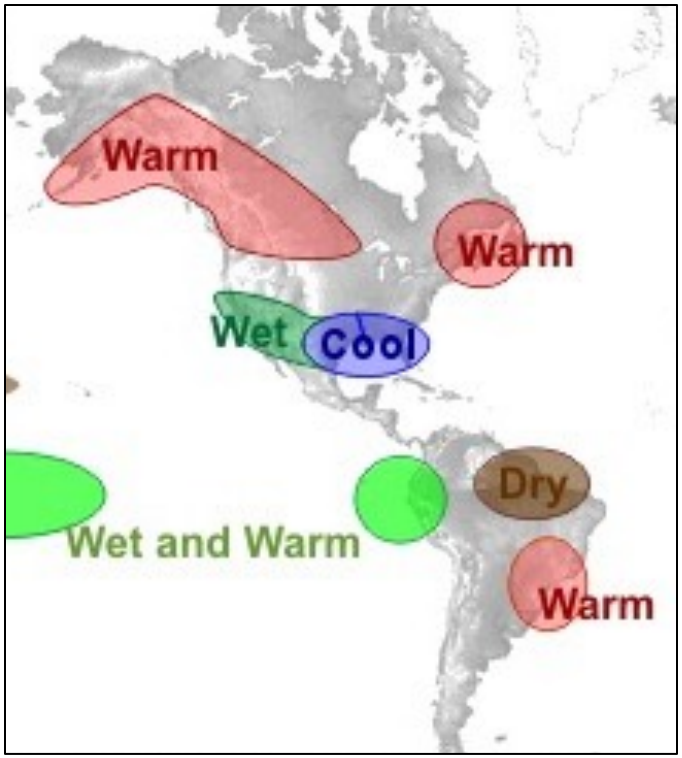
Tuesday, October 31, 2017

The Edgefield Advertiser
Oldest newspaper in South Carolina
"We will cling to the pillars of the temple of our liberties and if we must fall we will perish amidst the ruins."

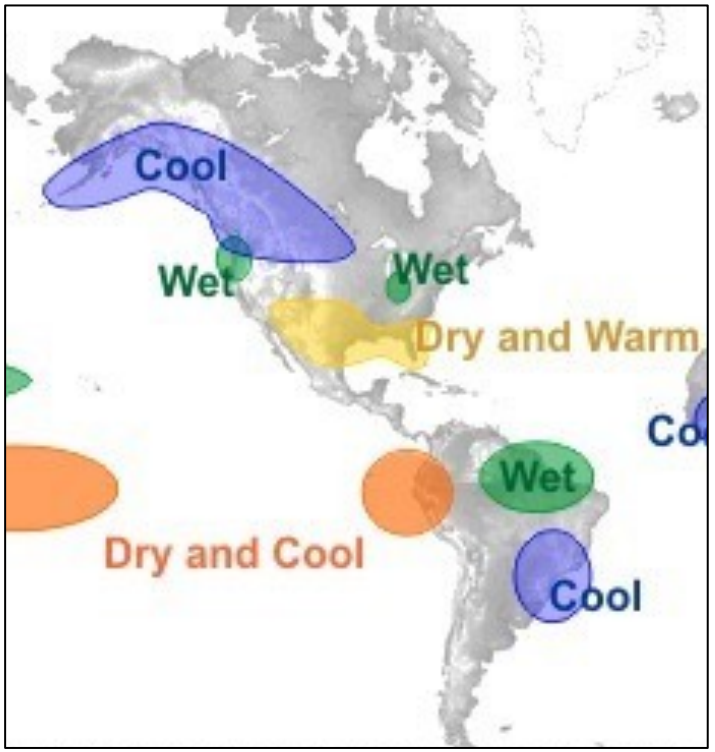
What Happens to Peaches When the Chill is Gone?

By Edgefield Advertiser on January 24, 2013 · Comments Off on What Happens to Peaches When the Chill is Gone?

El Niño year



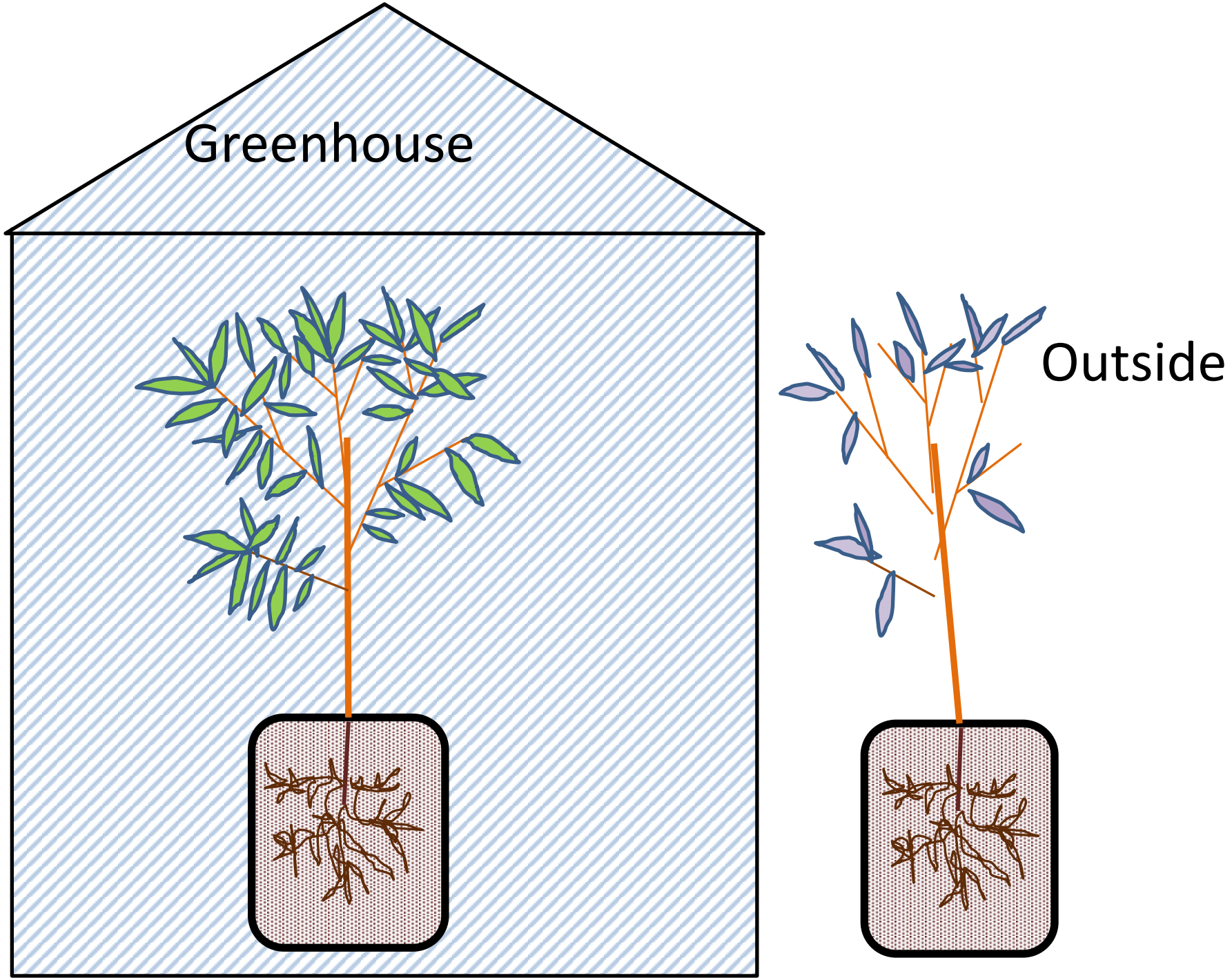
La Niña year

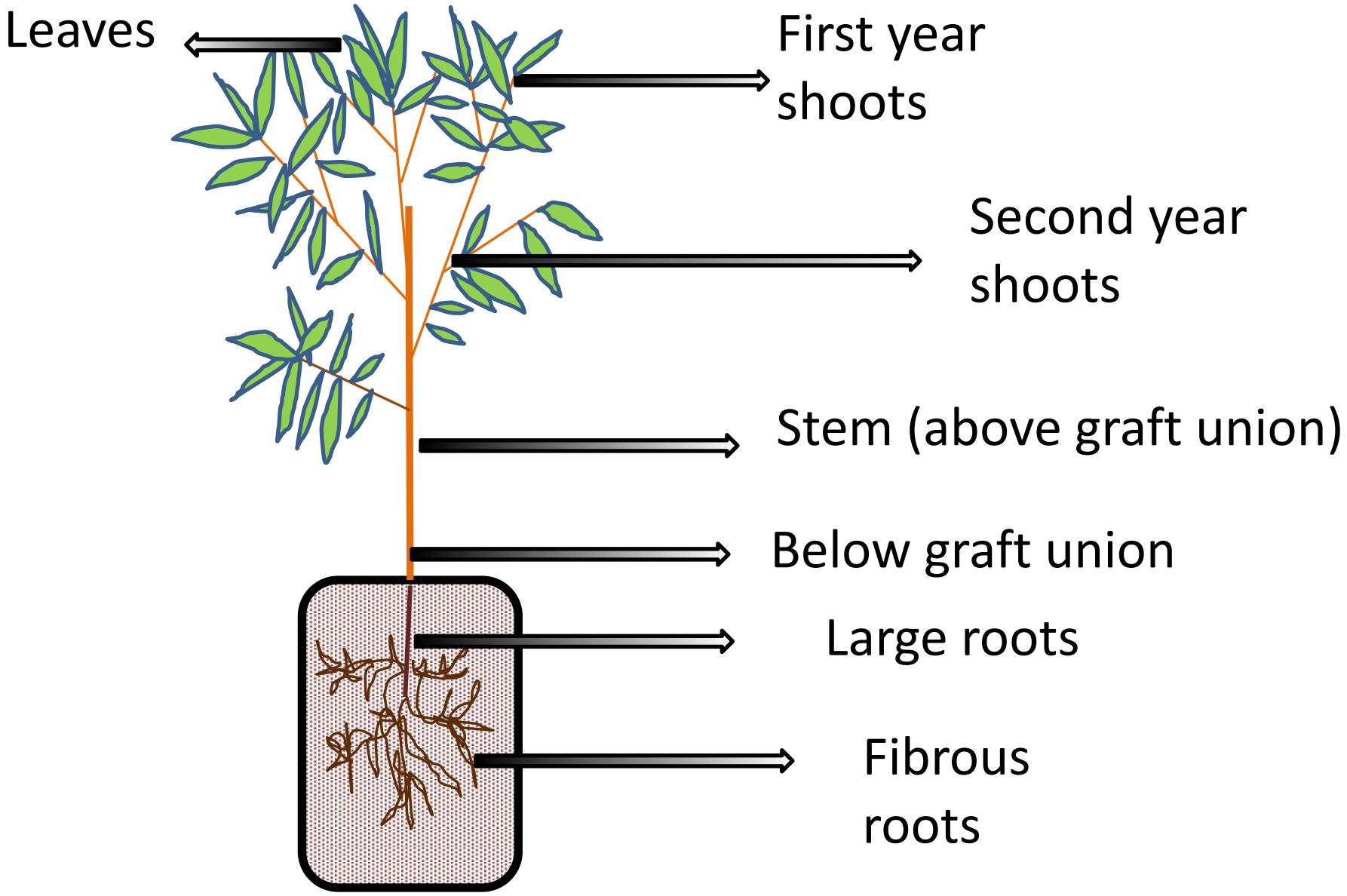


Source: http://www.srh.noaa.gov/jetstream/

How do environmental conditions affect nutrient reserves?

If senescence is delayed, do trees recover more nutrients?


Greenhouse
Outside


Leaves
First year shoots
Second year shoots
Stem (above graft union)
Below graft union
Large roots
Fibrous roots

Effect of delayed senescence in N concentration in reserve tissues during winter

Tissue	Greenhouse	Outside
1-year shoots	**1.86*** **	**1.57**
2-year shoots	0.97**	0.85
Stem	0.72***	0.61
Below graft union	0.92***	0.73
Large roots	**1.77*** **	**1.39**
Fibrous roots	**2.61**	**2.29**

n = 60-63. Analyzed with analysis of variance (ANOVA)

*** P < 0.001 ** P < 0.01

Did N come from the leaves?

Effect of soil moisture in N concentration in reserve tissues during winter

Tissue	100% ET	50% ET
1-year shoots	**1.63**	**1.80***
2-year shoots	0.86	0.95*
Stems	0.62	0.72***
Below graft union	0.76	0.89***
Large roots	**1.48**	**1.68***
Fibrous roots	**2.27**	**2.64*****

n=60-63. Analyzed with analysis of variance (ANOVA)

*** $P < 0.001$ * $P < 0.05$

Leaf analysis in summer

Acknowledgments

SC Peach Council

Southern SARE

SC Department of Agriculture

Musser Fruit Research Farm crew

Qi Zhou, Brian Lawrence


Questions?
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